From the Field: Field searches versus vaginal implant transmitters for locating elk calves

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Abstract We compared the utility of vaginal implant transmitters (VITs) and field searches for locating elk (*Cervus elaphus*) calves in southeastern Kentucky during the spring of 2001. Retention of VITs among 40 adult females ranged from 1–276 days ($\bar{x}=61.6\pm8.4$ [SE] days). Approximately half of the transmitters ($n=19$) were expelled prematurely or malfunctioned. Two of 37 (5%) transmitters in translocated females performed as designed and led to calf capture. We captured more calves ($n=9$ in 2001; $n=16$ in 2002) by searching areas where elk exhibited parturition behavior. We suggest that manufacturers refine the current VIT design to increase its application and cost-effectiveness.

Key words *Cervus elaphus*, elk, neonate, parturition, radiotelemetry, translocation, vaginal implant transmitter

Elk (*Cervus elaphus*) calves remain hidden after parturition (Darling 1937, Geist 1982) for up to 14 days. This behavior combined with their cryptic pelage coloration can make detection difficult. A variety of techniques has been used to locate and facilitate capture efforts of cervid neonates, but success rates are dependent on the landscape, researcher determination and experience, and funding. Reported approaches include the use of neonate distress calls to lure hiding neonates from cover (Johnson 1951, Diem 1954, Arthur et al. 1978), spotlighting (Steger and Neal 1981), systematic searches through known parturition habitat (Lund 1975, Ballard et al. 1999), monitoring the behavior of radiocollared, pregnant females (Huegel et al. 1985, Kunkel and Mech 1994, Vore and Schmidt 2001), VITs (Garrott and Bartmann 1984, Bowman and Jacobson 1998, Carstensen et al. 2003), and searches from helicopters over open terrain (Kuck et al. 1985, Smith and Anderson 1996, Singer et al. 1997). The last-named technique is expensive and may not be practical in rugged or forested areas. Use of VITs may be a more economical and less time-consumptive option (Carstensen et al. 2003).

Vaginal implant transmitters were developed to locate parturition sites and neonates for demographic studies. Implants may help alleviate sampling bias by aiding the capture of the youngest, most vulnerable animals for study. Since their introduction 2 decades ago, implants have improved in reliability. Early studies concluded that implants were unreliable (Garrott and Bartmann 1984, Nelson 1984). In fact, Garrott and Bartmann (1984) described reproductive complications in female mule deer (*Odocoileus hemionus*) when a purse-string suture was used to retain the transmitter. Conversely, an inert implant transmitter was developed for white-tailed deer (*O. virginianus*) that remained in place without sutures and that did not complicate reproduction (Bowman and Jacobson 1998). Carstensen et al. (2003) recommended this implant over monitoring parturition behavior to locate and capture white-tailed deer fawns. Kastler (1998) and Vore and Schmidt (2001) used a modified design of this implant for elk with marginal to moderate success and no apparent signs of reproductive complications.

As part of a calf survival study on a recently reintroduced herd in southeastern Kentucky (Seward 2003), we used VITs and field searches to locate elk calves. Herein, we compare rates of success and the relative cost-effectiveness of each technique.

Study area

We studied elk at Addington Wildlife Management Area (WMA) (formerly Cyprus-Amax WMA), a 7,400-ha coal mine centrally located within the 14-county, 1.06-million-ha restoration zone in southeastern Kentucky. Addington WMA consisted of 4,400 ha of forest, 2,000 ha of reclaimed grassland, and 1,000 ha of active mining (Larkin et al. 2004). The restoration zone was 79% second-growth mixed-mesophytic forest, 10% active and reclaimed surface mines, 9% agriculture, and 1.5% urban. Forests were comprised of >30 dominant canopy tree species (Braun 1950) that occurred on narrow winding ridges, steep side slopes, deep dendritic drainages, and tapering valleys (McFarlan 1943). Elevations ranged from 244–488 m above mean sea level (Overstreet 1984). Reclaimed surface mines were dominated by a variety of exotic grasses and forbs, including Kentucky-31 tall-fescue (*Festuca arundinacea*) and bush clover (*Lespedeza* spp.). Planted and colonizing woody species on the mines included black locust (*Robinia pseudoacacia*), hazel alder (*Alnus serrulata*), autumn-olive (*Elaeagnus umbellata*), and white pine (*Pinus strobus*). The climate is temperate humid continental with warm summers and cool winters (Overstreet 1984). Average annual temperature is 12°C, with a minimum January temperature of -4°C and a maximum July temperature of 30°C (Ulack et al. 1998). Annual precipitation averaged 122 cm, with the highest rainfall occurring in March and July (Ulack et al. 1998).

Methods

Thirty-seven adult female elk were captured by net gun from a helicopter (Schemnitz 1994) and transported to a holding facility at Hardware Ranch WMA, Utah, in February 2001. We classified elk as pregnant if blood serum progesterone exceeded 1 ng/ml (Schmitt et al. 1986, Bender et al. 2002). We fitted pregnant females with a Duflex® numbered ear tag (Destron Fearing Corp., South Saint Paul, Minn.), a collar-mounted very high frequency (VHF) radio-transmitter (Telemetry Solutions, Concord, Calif.; Telonics Inc., Mesa, Ariz.; and Lotek Engineering, Newmarket, Ont.), and a VIT (Advanced Telemetry Systems, Inc., Isanti, Minn.). Implants were equipped with a sensor that changed their pulse rate from 40 to 80 beats per minute when exposed to <34.4° C. Implants weighed 26 grams and had a battery-life expectancy of 160 days. Implant dimensions were body length of 246 mm including antennae (160 mm); 57-mm wing length; 9-mm wing width; and 14-mm body diameter. Because we were under time constraints relative to scheduled captures of elk in western herds, we used this readily available design despite its intended application in white-tailed deer. Nonetheless, the manufacturer had confidence in its suitability. We transported instrumented elk nonstop to Kentucky and released them immediately upon arrival at Addington WMA. Additional details regarding capture, disease-testing, and translocation can be found in Larkin et al. (2001, 2003).

We recaptured 3 adult females previously translocated to Addington WMA and equipped them with VITs in April (n=2 in 2001; n=1 in 2002). We immobilized these females using a DanInject delivery system (Wildlife Pharmaceuticals, Inc., Fort Collins, Colo.) and carfentanil citrate (Wildnil®, Wildlife Pharmaceuticals, Inc., Fort Collins, Colo.), tested them for pregnancy by rectal palpation (Greer and Hawkins 1967), and fitted them with an implant. We also randomly selected a group of radiocollared adult females (n=20 in 2001; n=24 in 2002) previously translocated to Addington WMA to monitor for parturition behavior without the use of VITs.

We located all radio-instrumented elk at least once each week during daylight using ground or aerial telemetry (Mech 1983). Ground locations were recorded opportunistically when researchers observed instrumented elk during searches for calves, carcasses, and dropped transmitters. During the calving season (15 May–30 June), we located all instrumented elk 2–3 times each week and females with VITs on a daily basis. We recorded locations as Universal Transverse Mercator coordinates (Grubb and Eakie 1988) with a Global Positioning System unit. We continued to monitor elk for parturition behavior when VITs malfunctioned or were expelled prematurely.

We initiated a calf search when an increased pulse rate from the implant was detected or when the signal amplitude was noticeably higher. We conducted field searches from 1 May to 30 June during 2001 and 2002 because some implants were expelled immediately prior to the calving season. We initiated calf searches for females without implants following movements away from the herd or restriction of spatial movements (Langley and Pletscher 1994, Vore et al. 1996, Vore and Schmidt 2001). Searches began where we recovered the implant or at the location where we first observed the female. Groups of 1-3 researchers systematically searched the area until the calf was found or until search time expired (1 hour). Calves were captured by hand as described by White et al. (1972) and fitted with a VHF transmitter mounted on an expandable collar (Advanced Telemetry Systems, Inc., Isanti, Minn.).

Results

We equipped 40 elk with VITs. Of the 37 translocated elk with implants, 14 died from capture-related injuries during the first 6 weeks post-release. We recovered 5 (36%) of these implants in the carcass, while we recovered the remainder ($n=9$) <150 m from the carcass. Mean retention of the implants for elk that died was 42.5 (SE=2.4) days. Fifteen implants, not including the 14 capture-related mortalities, were expelled prepartum (2 during the ~3,000-km transport to Kentucky, 10 post-release, 3 by immobilized elk). We subsequently observed 2 females with calves that prematurely expelled their VITs. We suspected battery failure in 1 implant because the signal was not heard after 14 days of monitoring. We failed to locate 2 females with implants after translocation.

Eighteen implants were still operating in elk on 1 May 2001. Pulse rates of 4 implants failed to change after expulsion and exposure to reduced ambient temperature. In these cases, we detected expulsion by increased signal amplitude and disparate locations between the implant and the radiocollared elk. We captured 2 calves 8 and 30 m from the expelled transmitters after 0.5 and 1.0 hour of searching, respectively. Mean retention for these 2 implants was 95 (SE = 0.5) days. Two females retained implants after the calving season for 154 and at least 276 days. The second implant was known to be retained until battery exhaustion. Both females successfully calved in 2002. Additionally, 64% of the elk instrumented with implants in 2001 that survived until the following year ($n=26$) produced a calf in 2002. Thus, implants do not appear to cause future reproductive complications when retained beyond the calving season.

We monitored 20 and 24 females without implants during the 2001 and 2002 calving seasons, respectively. We captured 25 calves by monitoring pre-parturition movements and behavior of females during the calving season. Parturition behavior that contributed to the capture of all radiocollared calves included adult female movements away from their centers of activity, reluctance to flee when approached by researchers, and bark vocalizations. We identified 57 calves by monitoring parturition behavior; however, 32 of these were too mobile (>7 days old; Wallace and Krausman 1985) for capture and inclusion in the survival study.

The cost of using implant transmitters was $5,175.00 (U.S.). We determined this value by multiplying the number of females with implants that survived 6 weeks after translocation ($n=23$) by the cost of each implant ($225.00). Thus, the estimated cost per calf captured by implant technology ($n=2$) was $2,587.50.

We invested an average of 34.5 personnel-hours (1-3 searchers) per calf captured by monitoring parturition behavior and performing field searches. We estimated the cost of monitoring for parturition without VIT technology at $8,000 (females were located 8 times during the month of April and 24 times during May and June with an average cost of $250.00 per flight). Thus, the estimated cost per calf captured with traditional field searches ($n=9$) was $888.90 for 2001. We excluded the associated costs of capture, handling, and the loss of instrumented females that died from capture-related injuries because these costs vary with capture techniques and researcher experience, however, these costs should be considered in future projects. We also assumed that personnel time and fuel costs were equally distributed between techniques.

Discussion

We found that VITs largely failed to facilitate calf captures. Early expulsion and malfunction severely limited their effectiveness. Similar results were reported in Montana, where 8 implants in free-ranging elk were "marginally useful" (Kastler 1998). Poor retention and transmitter malfunction have been prevalent problems with implants (Garrott and Bartmann 1984, Nelson 1984, Bowman and Jacobson 1998, Carstensen et al. 2003). Kastler (1998) observed battery failure in 38% of implants used in Montana. While battery failure was not a serious problem in our study ($n = 1$; 2.5%), only 18 (45%) translocated females retained their implants until 1 May (64 days post-instrumentation). We believe premature expulsion of the implants may have been caused by early contractions, stillborn passage, or by the individual pulling on the antennae. Our problems were further exacerbated by using readily available equipment designed for a smaller species.

Greer and Hawkins (1967) found the distance of the vaginal canal to be 200-255 mm with a cervical diameter of approximately 12-19 mm in pregnant 2.5-year-old elk. Because a multiparous adult cervix (>3.5 years of age) is approximately 51 mm in diameter (Greer and Hawkins 1967), we suggest that future researchers use VITs that are >14 mm in diameter and have a wing length >57 mm. A larger-diameter implant with wider wings may prevent premature expulsion, internal shifting/displacement, and reduce the likelihood of cervical puncture. We recommend use of a larger implant only in elk >3.5 years of age and that have likely given birth to at least one calf (Wisdom and Cook 2000). Additionally, to prevent females from pulling implants out with their mouths, the antennae should be adjustable to fit each animal. This is important because vaginal canal length also increases with age (Greer and Hawkins 1967).

We believe that the VIT design we used for elk is unreliable and results in a higher cost per calf compared to traditional monitoring and field searches. A more dependable and retainable implant must be designed before VITs make a significant contribution to research on free-ranging elk populations.

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